Hygiene of the Towel

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PUBLIC health authorities have expressed an almost universal desire to banish the common towel. In an effort to develop more concrete evidence that might answer the questions listed in this paper, the authors have made the bacteriological and physical studies described after each. Standard size towels were used in the experiments.

Question 1—When the hands are washed in the usual manner, are bacteria transferred to the towel in appreciable numbers?

The finger tips were inoculated with a 24-hour broth culture of *Flavobacterium lutescens,* a bright yellow chromogenic bacillus. They were held before an electric fan 15 minutes, drying the skin even beyond its normal condition. The hands were then washed with a toilet soap for 10 seconds, rinsed for 5 seconds to remove the soap, and wiped on a sterile Turkish hand towel. After 30 minutes' drying, the towel was examined for the number of bacteria present. Disks 2″ in diameter were cut from the center of the towel and one was placed in 100 c.c. of sterile physiological salt solution. Appropriate dilutions were plated in standard beef extract agar and incubated for 2 days at 37° C. when the number of yellow organisms developed from the 2″ disk was determined.

A second disk taken from the same towel was placed on a sterile agar surface for 10 seconds. Upon removal, an impression of the towel and some of the bacteria which had been present were left on the plate, which was also incubated for 2 days at 37° C.

In the case of the Turkish hand towel 48,000 bacteria per 2″ disk were removed from the finger tips, while the huck towel removed 15,000; so that in common washing practice, not only are large numbers of bacteria apparently transferred to towels, but, comparatively, Turkish towels remove larger quantities than huck.

Question 2—When several individuals use a common towel, may infectious bacteria be transferred from one individual to another?

Three separate investigations were conducted, under both exaggerated and ordinary conditions.

The first series were hand washing tests to show whether bacteria are transferred to subsequent users from original ones.

Individual 1 washed the hands thoroughly with soap and warm water for 1 minute. They were then dried by electric fan. One c.c. of a 24-hour broth culture of *Flavobacterium lutescens* was rubbed over both hands, which were again electrically dried for 15 minutes, and then washed with tap water at about 37° C. and cake toilet soap for 10 seconds; then rinsed for 5 seconds with running tap water and dried thoroughly on a sterile Turkish hand towel. Individual 2 washed his hands thoroughly with soap and warm water for a period of 1 minute, the degree of efficiency of which was determined by finger-printing a nutrient agar plate subsequently incubated at 37° C. for 48 hours. He then dried the hands on the towel which had been used 5 minutes previously by individual 1. After a simple drying of 20 seconds, finger-prints were again taken. The first photograph marked "No. 5 control" (Plate A) indicates a small number of bacteria present after the washing process.

Individual 2 then dried the hands on a towel which had been used 24 hours before by individual 1. After a simple drying of 20 seconds, finger-prints were again taken. The photograph marked "Turkish towel used 24 hours before" shows a much larger number of bacteria than photograph "No. 5 control." Several bright yellow colonies demonstrated a transfer by the towel from individual 1.

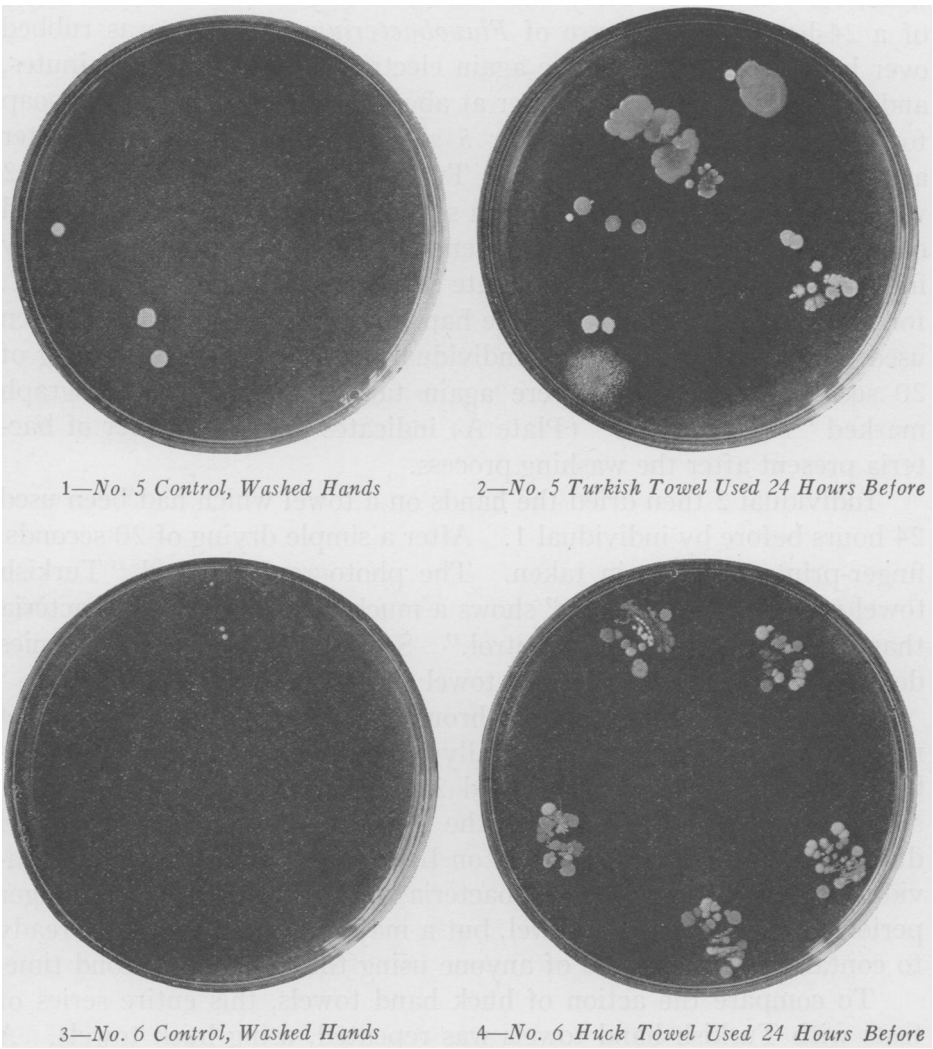
Rapid bacterial destruction through desiccation in the absence of nutrient material has been generally postulated. The results of tests by individual 2 after both 5- and 24-hour intervals were somewhat similar to those obtained after the 5-minute interval and indicated duration of viability of bacteria on the towel contamination by individual 1. Small numbers of bacteria died by reason of the longer periods of sojourn on the towel, but a major number remained, ready to contaminate the hands of anyone using the towel the second time.

To compare the action of huck hand towels, this entire series of tests with Turkish hand towels was repeated, using huck towels. A slightly greater number of bacteria were transferred to the hands at the end of the 5- and 24-hour periods (Plate A). This was confirmed in several tests and indicates readier pick-up of bacteria from the flat surfaces of the huck towel than from the rough surface of the Turkish hand towel.

The second series of studies comprised hand washing tests to demonstrate whether or not multiple infections can be transferred to each user of the common towel; i.e., to indicate what is apt to occur when a towel is infected by several people.

PLATE A

IMPRESSION INOCULATIONS ON AGAR BY FINGER TIPS AFTER WASHING AND RINSING, THEN DRYING ON USED TURKISH HAND TOWEL AND ON USED HUCK TOWEL



1—*No. 5 Control, Washed Hands*

2—*No. 5 Turkish Towel Used 24 Hours Before*

3—*No. 6 Control, Washed Hands*

4—*No. 6 Huck Towel Used 24 Hours Before*

In this series of studies four individuals participated, employing the same technic. Individual 1 washed his hands thoroughly with soap and warm water for 1 minute, afterward drying them for 15 minutes. One c.c. of a 24-hour broth culture of the bright yellow chromogen *Flavobacterium lutescens* was rubbed over the hands, which were dried as before, then washed with tap water at approximately 37° C. and cake toilet soap for 10 seconds. The hands were then rinsed for 5 seconds and dried on a sterile Turkish hand towel.

Individual 2 repeated the same process with hands inoculated with 1 c.c. of a 48-hour broth culture of the easily distinguishable, red *B. prodigiosus*. Finger-prints on agar plates were made after wiping the hands on the towel infected by individual 1. The plates were incubated for 48 hours at 30° C., when they showed many bright yellow colonies and a still larger number of red colonies, indicating infection of the hands of individual 2 by the organism left on the towel by individual 1.

Individual 3 repeated the same process with hands inoculated with 1 c.c. of a 24-hour broth culture of the light orange *M. aureus,* to distinguish this organism from those used in inoculating the hands of individuals 1 and 2. Finger-prints on agar plates were made after wiping the hands on the towel previously used by individuals 1 and 2. The plates were incubated for 48 hours at 30° C. They showed many bright yellow and red colonies and a still larger number of light orange colonies, indicating that individual 3 had become infected by the organisms left on the towel by individuals 1 and 2.

Individual 4, after thoroughly washing the hands, employed the towel previously used by individuals 1, 2, and 3. After the usual wiping process, finger-prints were made as before. The plates showed the presence of all three organisms, indicating that the hands of individual 4 had become infected with all three organisms left on the towel by the three previous users.

A huck hand towel was used in a further series of tests. The results were identical, except the numbers of bacteria transferred to individuals 2, 3, and 4 were greater.

It was thus clearly indicated that infectious bacteria may be easily transferred in increasing varieties and numbers through the use of the common towel, especially by the huck hand variety.

The next series of studies considered the accumulation of bacteria on the towel when used by different individuals and whether the varieties of bacteria increased when the towel was used by them. Turkish and huck hand towels were used on four occasions by four different individuals as previously described. Imprints were made after one individual had used the towel and again after four had used it, when it was observed to carry decidedly increased numbers of bacteria.

A further series of tests was conducted to show whether an increase in the varieties as well as numbers of bacteria would occur. When one person used the Turkish towel, an average of over ten types of bacteria was found. The same towel after use by four individuals showed an average of over twenty types of bacteria.

The organisms used in the studies thus far, with the exception of *Micrococcus aureus,* would be classifiable as non-pathogenic.

Many have believed that pathogenic bacteria die rapidly through desiccation, even in the absence of sunlight. If infectious organisms such as might find their way to the common towel were capable of remaining alive over periods of 24 or 48 hours, a real danger would be indicated when the ease of transfer as shown in the previous results is considered.

The next series of studies was conducted to determine whether various species of pathogenic organisms would remain alive for periods of 24 and 48 hours. Sterile disks 2″ in diameter were inoculated with cultures of the following infectious organisms: *Bacillus typhosus, Bacillus paratyphosus "B," Bacillus diphtheriae, Streptococcus hemolyticus scarlatinae, Streptococcus hemolyticus, Pneumococcus Type II.* In each case the organisms were grown on a suitable solid culture medium and, to avoid carrying over to the towel any culture medium which might aid the organism in remaining alive, only the surface growth was used. After inoculation, the disks were placed in clay-top Petri dishes at room temperature and subjected only to a north light. At intervals of 24 and 48 hours, disks of each type of towelling were removed and small portions transferred to suitable culture media. After incubation for 48 to 72 hours, macroscopic and microscopic examinations were made.

TABLE I

VIABILITY OF PATHOGENIC MICROÖRGANISMS ON DRY TOWELLING
(In absence of direct sunlight)

Test Organisms	Alive at end of 24 hours		Alive at end of 48 hours	
	Turkish	Huck	Turkish	Huck
B. typhosus	+	+	+	+
B. paratyphosus "B"	+	+	+	+
B. diphtheriae	+	+	+	+
Streptococcus hemolyticus scarlatinae	+	+	+	+
Streptococcus hemolyticus	+	+	+	—
Pneumococcus Type II	+	+	—	—

Living infectious organisms of all these varieties were present on both Turkish and huck hand towels for a period of 24 hours. No pneumococcus survived for 48 hours. *Streptococcus hemolyticus* may or may not die under these conditions within 48 hours. Apparently, therefore, real dangers from infectious organisms exist in the common towel for at least 48 hours after primary contamination.

Question 3—Will the repeated use for several days by one individual show an accumulation of bacteria on the towel?—what is the sanitary significance of such accumulations?

Studies were conducted to bring out the possible accumulation of

bacteria during the normal home use of the large Turkish towel upon the entire body; the small Turkish towel upon the hands and face; and the huck towel upon the hands and face. Four individuals participated in each of the three series.

LARGE TURKISH TOWELS

Twenty-four large Turkish towels were washed, wrapped separately in paper and sterilized in an autoclave. Six of these prepared towels were given to each of four persons, one of which was used but once to dry the entire surface of the body and was returned to its wrapper and the laboratory for testing. The second was used in the same way on each of 2 consecutive days and then wrapped and returned. The third was likewise employed on each of 3 consecutive days and the fourth, fifth and sixth towels were similarly used on 4, 5 and 6 consecutive days respectively. Between times they hung on the bathroom towel racks under normal home conditions. After each period, determinations were made in the laboratory of the accumulated numbers of bacteria on the towels during the several periods covered. Four 2″ disks were removed from different parts of the towels. Three disks were placed in 100 c.c. of sterile physiological salt solution and appropriate dilutions were plated separately in standard beef extract broth. The average of the results for the three disks was taken as the bacterial count for each towel used for the given time period. The results appear in Table II.

TABLE II

BACTERIAL COUNTS FROM TWO-INCH DISKS TAKEN FROM LARGE TURKISH TOWELS USED BY ONE INDIVIDUAL ONE BATH A DAY—FOR PERIODS OF ONE TO SIX DAYS

Number of Days Towel Was Used	Individual 1	Individual 2	Individual 3	Individual 4
1	26,500	38,000	700	4,500
2	17,500	180,000	4,700	18,000
3	46,500	110,000	16,000	9,600
4	100,000	410,000	38,000	43,000
5	100,000	300,000	203,000	81,000
6	240,000	310,000	800,000	178,000

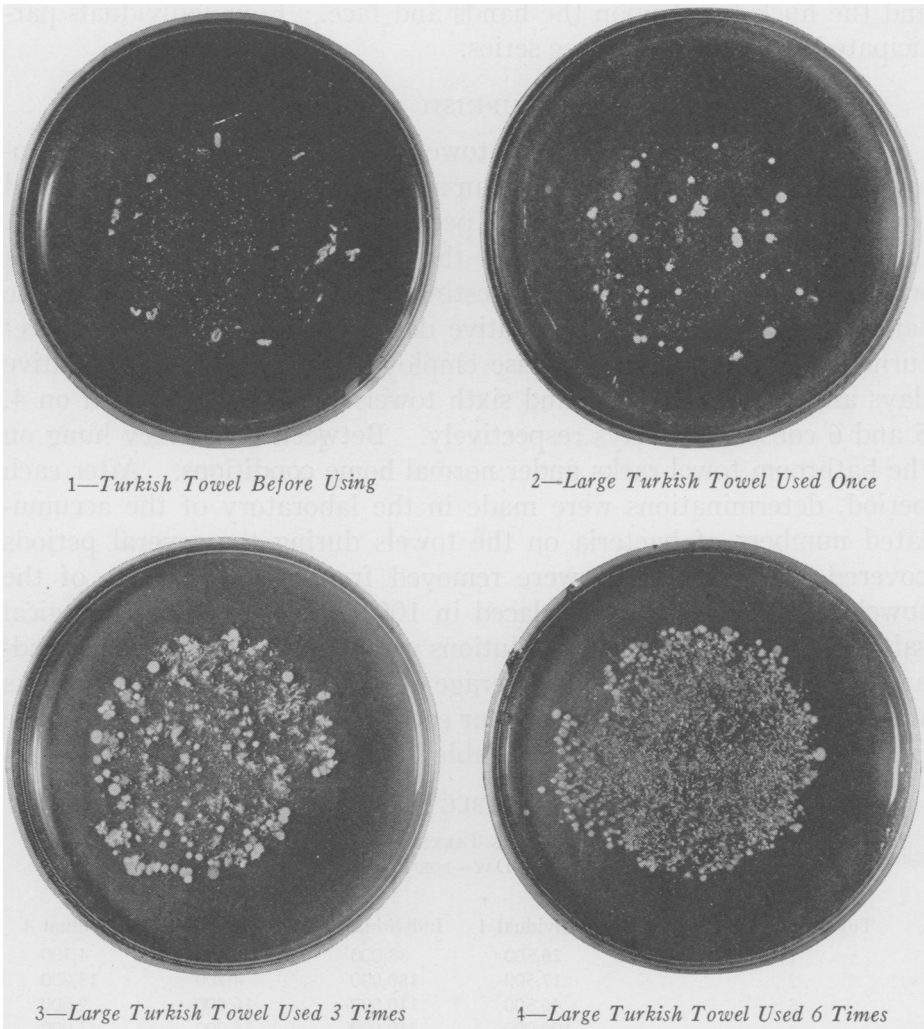
The remaining disk from each of the towels was imprinted on a nutrient agar plate to indicate the distribution of the bacteria on the disk and their increase in numbers. The plates were incubated at 37° C. for 48 hours, and one set including the control was photographed (Plate B).

In each case the imprints indicated a decided increase in the number of bacteria. In the photographs the loose threads or portions of threads may be distinguished readily from the colonies of bacteria.

The results indicate clearly that when a bath towel is used more

PLATE B

IMPRESSION INOCULATIONS ON AGAR BY DISKS CUT FROM TURKISH BATH TOWEL



1—*Turkish Towel Before Using*

2—*Large Turkish Towel Used Once*

3—*Large Turkish Towel Used 3 Times*

4—*Large Turkish Towel Used 6 Times*

than once bacteria accumulate on it. Variations in results from the towels used by different individuals were remarkably small.

TURKISH HAND TOWELS

A similar series of tests was conducted by four individuals using a small Turkish hand towel, morning and night, to dry the face and hands, during each of six periods, each period ranging from 1 to 6 days. The results appear in Table III.

The agar plate impressions of the 2″ disks taken from the towel used by the four individuals showed approximately the same graphic

TABLE III

AVERAGE BACTERIAL COUNTS ON TWO-INCH DISKS TAKEN FROM TURKISH HAND TOWELS EACH USED BY ONE INDIVIDUAL—MORNING AND NIGHT—FOR A PERIOD OF 1 TO 6 DAYS

Number of Days Towel Was Used	Individual 1		Individual 2		Individual 3		Individual 4	
	Number of times used	Bacterial Counts	Number of times used	Bacterial Counts	Number of times used	Bacterial Counts	Number of times used	Bacterial Counts
1	3	3,800	5	25,500	4	11,500	5	20,500
2	6	9,000	10	55,000	8	9,900	8	48,000
3	10	17,800	15	54,000	12	16,000	13	57,000
4	15	83,000	20	140,000	18	84,000	18	113,000
5	17	70,000	25	143,000	22	180,000	24	95,000
6	20	174,000	30	294,000	28	210,000	30	133,000

results as those obtained in the tests with the Turkish bath towel. The numbers of bacteria were not quite so great but clearly indicated the accumulation and survival of bacteria during different periods of use. Again there were remarkably small variations between individuals for the various time periods.

HUCK HAND TOWELS

Another series of tests was conducted exactly as those previously described for the Turkish hand towels. The results are given in Table IV.

TABLE IV

BACTERIAL COUNTS ON TWO-INCH DISKS TAKEN FROM HUCK HAND TOWELS EACH USED BY ONE INDIVIDUAL—MORNING AND NIGHT—FOR A PERIOD OF 1 TO 6 DAYS

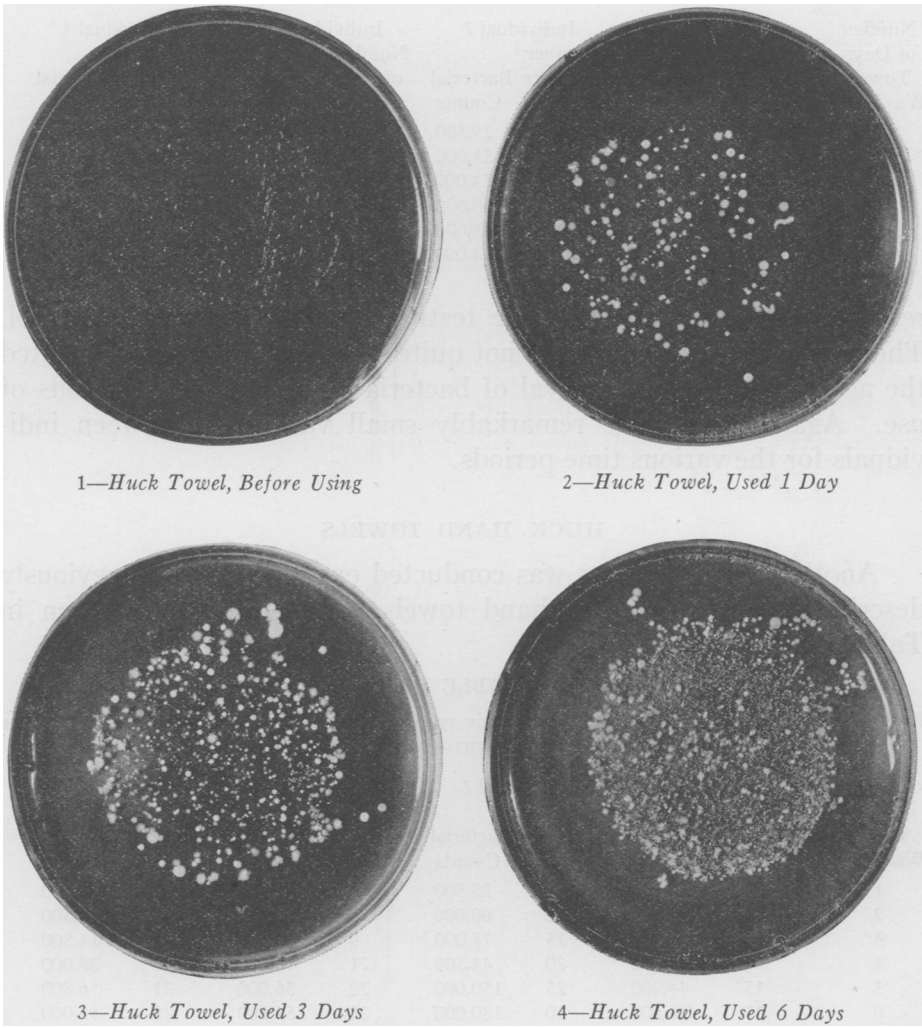
Number of Days Towel Was Used	Individual 1		Individual 2		Individual 3		Individual 4	
	Number of times used	Bacterial Counts	Number of times used	Bacterial Counts	Number of times used	Bacterial Counts	Number of times used	Bacterial Counts
1	2	12,500	6	25,500	5	12,500	6	11,000
2	6	27,000	12	60,000	6	48,500	9	18,500
3	9	38,500	15	75,000	9	38,500	16	14,500
4	16	52,000	20	44,500	21	13,000	18	38,000
5	15	44,000	25	150,000	22	56,000	21	6,800
6	17	96,500	30	180,000	24	54,500	28	15,000

Substantially the same photographic results were obtained from disk tests as in the two preceding studies (Plate C). A comparison of photographs of the huck with those of the small Turkish towel indicated a larger number of organisms in the case of the former. For comparison, averages of the results obtained on the three types of towels by each of the four individuals are given in Table V, which indicates that larger numbers of bacteria were removed and accumulated by both types of Turkish towelling than by the huck towelling.

The results of these tests decisively show the accumulation of bacteria on a towel used more than once by even one individual. If the

PLATE C

IMPRESSION INOCULATIONS ON AGAR BY DISKS CUT FROM HUCK HAND TOWEL



1—*Huck Towel, Before Using*

2—*Huck Towel, Used 1 Day*

3—*Huck Towel, Used 3 Days*

4—*Huck Towel, Used 6 Days*

same towel were used by several, similar results should be obtained.

Considering the sanitary significances of such accumulations of bacteria, the results obtained in answering *Question 2* indicate that the individual who uses the same towel on the face, hands or body more than once will not only remove a considerable number of bacteria from the skin but will simultaneously become re-inoculated with the bacteria which he left on the towel previously. The dangers of this practice might be illustrated by an individual who with hands which had become accidentally contaminated with typhoid bacilli washes them ineffectively and dries them on the towel. With the

TABLE V

AVERAGE BACTERIAL COUNTS ON TWO-INCH DISKS TAKEN FROM TURKISH BATH TOWELS, TURKISH HAND TOWELS, AND HUCK HAND TOWELS

Number of Days Towels Were Used	Turkish Bath Towel	Turkish Hand Towel	Huck Hand Towel
1	17,400	15,200	15,300
2	54,500	30,400	36,000
3	70,000	36,400	42,800
4	148,000	105,000	36,500
5	171,000	122,000	64,200
6	382,000	202,000	61,500

next use of the towel, perhaps hours or days later, the hands would re-acquire some of the bacilli which had been previously transferred to the towel and the possibility of infection of food or anything entering the mouth would be substantially as great as at the time of the original contaminations. The numbers of typhoid bacilli would likely be smaller but the opportunity for infection would remain.

In view of these studies, the use of the individual towel more than once must be considered as potentially menacing, and its repeated use, especially over periods of days, should be avoided.

Question 4—Which of the three types of towels—Turkish, huck, and paper—will prove most efficient in the removal of bacteria from the skin?

The results of the foregoing studies have clearly shown the towel as an important factor in removing bacteria from the skin. The selection of the type of towel capable of removing the largest numbers of organisms from the skin therefore becomes important as a sanitary measure. To this end, determinations were made of the numbers of bacteria remaining on the skin after the use of Turkish, huck, and paper types of hand towelling.

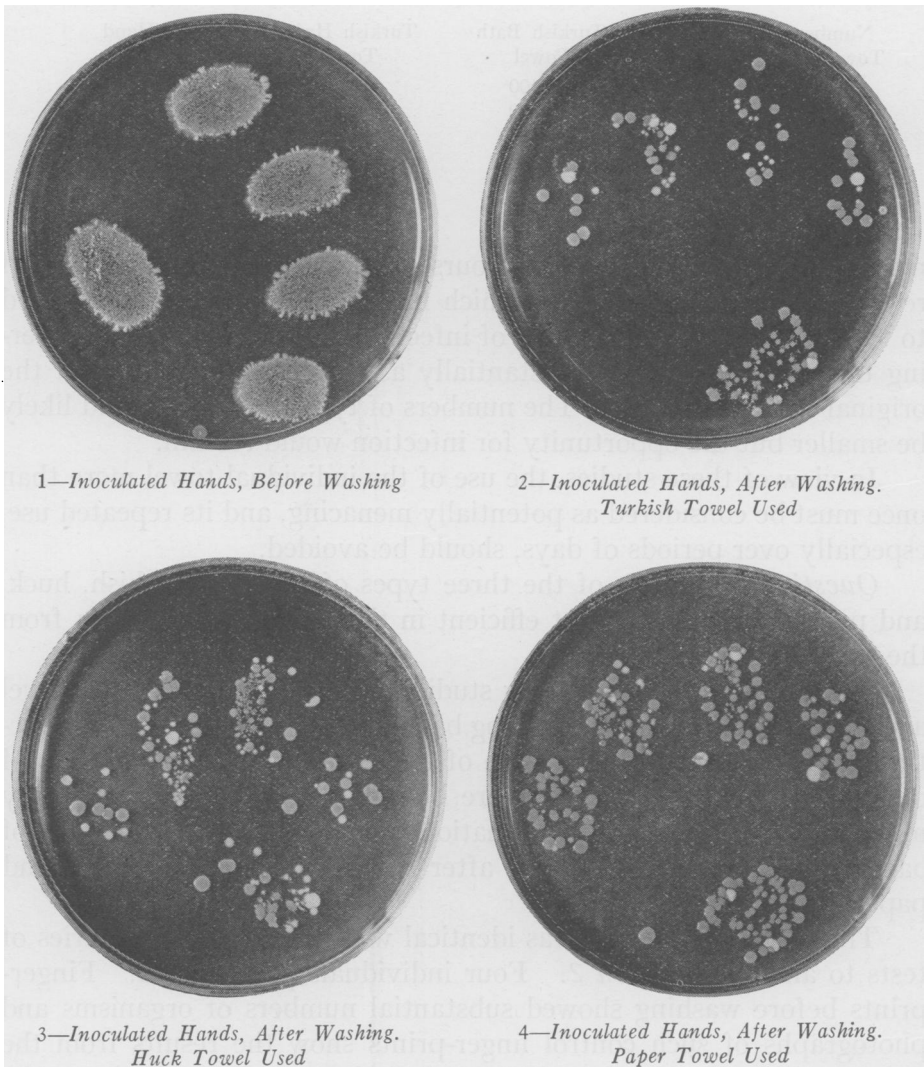
The technic employed was identical with that in the first series of tests to answer *Question 2*. Four individuals participated. Finger-prints before washing showed substantial numbers of organisms and photographs of such control finger-prints show the results from the unwashed hands. During the actual testing, no finger-prints of the unwashed hands could be made, as this would have removed sufficient numbers of bacteria to vitiate the results (Plate D).

After washing the hands, each individual used a Turkish hand towel, the huck, and the paper hand towel in successive tests. When the hands were dried, imprints on agar plates were made and the latter incubated for 48 hours at 37° C.

Photographs of the finger-prints of one individual demonstrate the differences found. These are representative of the results obtained from the tests on all four individuals. They indicate that smaller

PLATE D

IMPRESSION INOCULATIONS ON AGAR BY INOCULATED FINGER TIPS



1—*Inoculated Hands, Before Washing*

2—*Inoculated Hands, After Washing. Turkish Towel Used*

3—*Inoculated Hands, After Washing. Huck Towel Used*

4—*Inoculated Hands, After Washing. Paper Towel Used*

numbers of bacteria remained on the hands when using the Turkish hand towel than with the huck hand towel. Substantiating the previous studies, the largest number of organisms remained on the hands when the paper towel was used, which was to have been expected, since one usually blots with a paper towel rather than rubs the skin dry (Plate D). A definite guide is thus afforded indicating the Turkish towel as more efficient with one using than either the huck or the paper towel. The paper towel is employed but once, the others should be used but once also.

Question 5—Which of the three types of towels—Turkish, huck, or paper—will be most efficient in removing visible dirt from the skin?

From observation and comparison of the three types of towelling, the Turkish, having a loose, flexible thread with a rough yet pliable exterior and therefore an increased surface for contact with the skin, should be able to remove from the uneven surface of the hands a larger amount of visible dirt than the huck, and still more than the paper towel. To help demonstrate the difference between the action of the several types of towelling, exaggerated conditions of dirty skin were produced in the first of a series of tests by rubbing, with a little water, 0.1 gm. of lamp black onto the hands. After it had dried for 15 minutes, they were washed as usual for 10 seconds with cake soap and water. After rinsing for 5 seconds they were dried on the Turkish hand towel. Observations of hands and towel were recorded. The day following, the same tests were made by four individuals using the huck hand towel and repeated the next day using paper towels.

The superiority of the Turkish type of towel was again evidenced since larger amounts of lamp black were retained by it than by the huck and much more than by the paper towel, while the skin of the Turkish towel user was cleaner than that of those who used either of the others.

Because so substantial an amount of lamp black had been used in the first tests, they were repeated with as small quantities of lamp black as 0.01 and 0.002 gm. Little difference could be observed in the appearance of the towels as between the Turkish and huck varieties, but again the hands of each individual were cleaner where the Turkish type had been employed. Although crude, this series of tests demonstrates that the Turkish hand towel is superior to the huck or paper type in removing foreign matter from the skin. Single service hand towels, preferably of the Turkish type, give the cleanest appearing hands.

SUMMARY

The results of the investigation show some of the effects of the use or misuse of towels and the important part towels may play in the spread of bacteria which may be of disease producing types.

Although public health officials have recognized that the skin, especially that of the hands, may be one of the most important modes of transfer of disease producing organisms, and that diseases other than those of known bacterial origin may also be readily carried by the same means, the part played by the misuse of towels and the relative merits of types of towels have not received so much attention. Tests to secure evidence regarding these points indicate that:

Bacteria are transferred from the hands to the towel in surprisingly large numbers.

Bacteria are readily transferred from one user to another through the medium of the towel.

Most of the common disease producing bacteria, even though in a dry state, may remain alive on the towel for at least 24 hours and generally longer, making the common towel a constant and continued source of danger.

When the towel is used repeatedly by the same individual the numbers of bacteria on and in it are increased and some of these in turn may be restored to the hands of the user. Potential danger exists of a possible re-infection of the hands with disease producing organisms left on the towel by prior use. Repeated drying with an individual towel is not a good sanitary practice.

The Turkish towel, owing to its construction and a consequently greater number of points of contact with the skin, removes greater numbers of bacteria and dirt particles from the skin than the huck towel or the paper towel.

CONCLUSIONS

The common towel in public or in the home is an ever present menace as a potential carrier of disease producing organisms which thus may be easily transferred to the hands of each new user.

Whether for drying the face, hands, or entire body, the employment of an individual single service towel constitutes a wise precaution against excessive numbers of relatively harmless or of disease producing contaminations by bacteria already on previously used towels.

The Turkish towel is more efficient than the huck or the paper towel in removing bacteria and dirt from the skin.

Most Automobile Accidents Due to Law Violation

CAREFULLY compiled statistics in California show that traffic laws have been violated in connection with 60 per cent of the fatal automobile accidents in that state and that inexperienced drivers are involved in about 80 per cent of all fatal motor mishaps. These facts give a very practicable basis for launching a definite campaign against highway accidents that offers hope for a long time overdue improvement in the accident rate.

In California a system of recording accidents and law violations has been adopted. This includes the name of the drivers involved. When three charges are found against the same individual within a 6-months period, the individual is required to undergo a special examination to determine his competency as a driver. In view of the statistical evidence cited above the California system, if prosecuted vigorously, ought to bring about a significant improvement in the automobile accident situation.